MARKETING SLAUGHTER STEERS BY CARCASS GRADE AND WEIGHT

by

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TABLE OF CONTENTS

INTRODUCTION..... 1

Definition of Terms..... 3

Statistical Definitions..... 4

REVIEW OF LITERATURE..... 5

METHOD OF PROCEDURE..... 10

Sampling Technique..... 10

Plant Procedure..... 12

LIMITATIONS..... 15

ANALYSIS AND INTERPRETATION..... 20

Dispersion of Grade Errors..... 24

Dispersion of Yield Errors..... 32

Dispersion of Price Errors..... 36

Percentage Contribution..... 45

Probability of Specified Price Errors..... 47

Dispersion of Error "X"..... 50

VARIABILITY OF CERTAIN BY-PRODUCTS..... 52

SUMMARY..... 54

ACKNOWLEDGMENT..... 58

BIBLIOGRAPHY..... 59

APPENDIX A..... 62

APPENDIX B..... 67

APPENDIX C..... 68

APPENDIX D..... 69

INTRODUCTION

Successful marketing systems in other parts of the world have always attracted the attention of marketing specialists in this country. For several years the apparent success of the Canadian method of marketing slaughter cattle by carcass weight and grade has aroused considerable interest in the United States. Attempts are now being made to evaluate the desirability and practicability of using a similar method in this country.

To study this question the North Central Livestock Marketing Research Committee set up the Cooperative Regional Research Project, "Marketing Slaughter Livestock by Carcass Weight and Grade", under provisions of the Research and Marketing Act.[1] The sub-project most applicable to their main livestock interest was chosen by each state in the region. Because of the importance of the cattle industry in this state, Kansas chose the sub-project, "Marketing Slaughter Cattle by Carcass Weight and Grade".

Part of the justification for this project which was given by the North Central Regional Livestock Marketing Committee is quoted below.[2]

> Livestock constitutes the principal source of income to farmers of the North Central Region.
>
> The problem of marketing slaughter livestock by carcass weight and grade is one that requires for its solution

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[1]Public Law 733, Title I, Section 9(b)3, 78th Congress.
[2]Project Outline, Cooperative Regional Research Project, North Central Livestock Marketing Research Committee.

a regional approach, since the kind, quality and condition of livestock vary from area to area within a given state, and probably vary even more between states. Methods of marketing also vary from area to area within a given state and between states. Processing and slaughtering methods vary from one packing plant to another even in the same area. Conclusions derived from studies in one plant or in one state would not apply fully to a larger region. Such conclusions might even be misleading insofar as the larger region is concerned.

The laboratory for this project, therefore, cannot be centered in any one state. It must embrace both large and small packing plants in several states. And the studies should be carried out on a uniform basis so that the data will be comparable.

Under the present system of marketing slaughter livestock, the buyer determines the price he will pay for the live animal by estimating the value of the meat and other products it will produce. The buyer arrives at this value by estimating both the dressing yield of the animal and the weight and grade of the carcass and other products. It is difficult even for experienced buyers or sellers to do this accurately. Consequently, any method that shows promise of greater accuracy should be carefully explored so that producers may be paid in accordance with the weight and grade of product delivered.

Marketing specialists are constantly seeking new methods of marketing which might reflect more accurately the market value of a product back to the producer without resulting in an additional cost to the consumer. The main objective of this study was to determine how accurately the present method of marketing slaughter steers by live weight reflects back to producers the differences in value of different animals to the packer.

Definition of Terms

Live weight system of marketing - a system in which prices are based on the live weight and a given price per hundredweight; the method now practiced in the United States.

Carcass weight and grade system of marketing - a system in which price is based on the actual carcass weight and grade. Grading is done by an unbiased grader. Price differentials are set up for the various grades. Also referred to as "rail grade and weight" and "dead weight and grade".

Carcass weight - the weight of the carcass after cooling for a 24 hour period. For this study, it is the weight of the hot carcass immediately preceding shrouding, arbitrarily shrunk 2.13 percent. The percentage was furnished by the cooperating packer.

Carcass yield - the weight of the cold carcass expressed as a percentage of the live weight.

Carcass grade - referred to as "grade" throughout the thesis.

(1) Official - the grade of the cold carcass as determined by a grader employed by the Production and Marketing Administration, U. S. Department of Agriculture. Grading was done according to standards determined by that authority.[1] U. S. grade is referred to in study as a "full grade".

Symbols used:	U. S. Grade	1/3 Grade
Choice	AA	AA 1 AA 2 AA 3
Good	A	A 1 A 2 A 3
Commercial	B	B 1 B 2 B 3

[1] "Amendment No. 1 To Service and Regulatory Announcements No. 99, Official United States Standards for Grade of Carcass Beef," Agricultural Marketing Service, U. S. Dept. of Agr., July, 1939.

	U. S. Grade	1/3 Grade
Utility	C	C 1 C 2 C 3
Cutter	D	D 1 D 2 D 3
Canner	E	E 1 E 2 E 3

(2) Estimated - the buyer's estimate of the live animal's probable carcass grade. In this thesis, the same symbols as above were used to denote this estimate.

(3) Packer - the grade of the cold carcass as determined by a grader employed by the packer, using standards set up by the packer. Used in the regular commercial trade of the cooperating packer. Very similar to U. S. standards.

Statistical Definitions

Arithmetic mean - an average of a group of individual items. Referred to in the thesis as "mean".

Standard deviation - the square root of the average of the squares of the positive and negative deviations from zero.

REVIEW OF LITERATURE

Because the system of marketing cattle by carcass weight and grade is comparatively new, only a small amount of literature is available on the subject. Although various experiments have been conducted in this country on the marketing of hogs by this system, little has been done with beef. In 1929, several articles appeared in "Wallaces' Farmer"[1] pertaining to the value of hogs to the packer in relation to the prices paid to the producer and to the comparison of the grading of hogs on foot to the grading on the rail. In 1932, a closely related study was conducted in Ohio on the factors influencing the dressing percentage of hogs[2], and it was found that there was only a slight relationship to yield of the production factors such as kinds and amounts of feed, condition of animals and distance hauled to market. It also was concluded that yield differences could not be determined on the hoof and that live grading was not reliable. In his writings in 1939, Shepherd[3] reviewed the livestock marketing methods in Denmark, Great Britain and Canada. He reported that all hogs bought in Denmark were purchased on the individual carcass weight and grade basis while in England, separate "schemes" were found

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[1]Wallaces' Farmer, Vol. 54:27, p. 967; 28, p.996; 40, p. 1327, 1929.

[2]Henning, G. F., W. B. Stout, "Factors Influencing the Dressing Percentage of Hogs", Ohio Agr. Expt. Sta. Bul. 505, p. 32, August, 1932.

[3]Shepherd, Geoffrey, "Livestock Marketing Methods in Denmark, Great Britain, and Canada", Iowa Agr. Expt. Sta. Bul. 353, p. 160, January, 1937.

for the marketing of hogs and other livestock. There, hogs were marketed on a carcass weight and grade basis, prices being set monthly by means of a fixed formula based on the costs of a specified hog feeding ration and the wholesale price of bacon. For other livestock there was a voluntary scheme, the National Grade and Dead Weight Scheme, in which cattle and sheep were marketed by carcass weight and grade. Shepherd said,[1] "The numbers of livestock handled under this scheme are increasing rapidly, but the percentage of the total livestock is still small (January, 1937)." He also discussed the marketing of hogs by the carcass weight and grade system which had been in effect in Canada since 1934, mentioning some of the problems encountered by the Canadian packers and their methods of solving them. Since these problems all pertained to hogs, no mention of them will be given here. In 1938 and 1940, two other experiments were conducted in this country, but again they pertained only to hogs. One of the experiments, conducted by the United States Department of Agriculture, concerned the shrinkage and dressing percentage of hogs.[2] Iowa conducted the other experiment to determine the advantages of the new system of marketing hogs and some of the problems which would be encountered with its adoption.[3] Dowell

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[1]Shepherd, Geoffrey, op. cit., p. 115.

[2]Bjorka, Knute, "Shrinkage and Dressing Yields of Hogs," Technical Bulletin No. 621, U.S.D.A., p. 22, June, 1938.

[3]Shepherd, Geoffrey, Fred J. Beard, and Arval Erikson, "Could Hogs be Sold by Carcass Weight and Grade in the United States?", Iowa Agr. Expt. Sta. Res. Bull. 270, p. 445-506, January, 1940.

and Bjorka[1] discussed the desirability, practicality and economic aspects of the system in their book, also summarizing many of the studies conducted prior to 1941. Part of their summarizing statements are quoted below.

> The fact that this method of marketing has been found to be more effective than other methods in a number of countries has led some to the conclusion that it should be adopted in the United States. Results secured in a number of preliminary studies, particularly with hogs, appear to lend support to this conclusion. However, it is recognized that conditions in the United States differ greatly from the situation that prevails in the countries where this method is now in operation. Consequently, much careful research work will be required before final judgment can be rendered...It is altogether probable that this will prove to be one of the most fruitful fields to be explored by those who are interested in more effective livestock marketing.[2]

Several studies have been conducted in an attempt to relate various objective measurements to the present subjective grades of cattle. In tests conducted by Black et al.[3] some significant correlations were obtained between carcass grade and the height at the wither, body length and heart girth. However, these correlations were not high enough for practical use. In order to find an index of merit for cattle, Hankins et al.[4] attempted

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[1]Dowell, A. A., and Knute Bjorka, Livestock Marketing, McGraw-Hill, New York, p. 428-454, 1941.

[2]Dowell, A. A., and Knute Bjorka, op. cit., p. 453.

[3]Black, W. H., Bradford Knapp, Jr., and A. C. Cook, "Correlation of Body Measurements of Slaughter Steers with the Rate and Efficiency of Gain with Certain Carcass Characteristics", Journal of Agricultural Research, U.S.D.A., Vol. 56, pp. 465-472, 1938.

[4]Hankins, O. G., Bradford Knapp, Jr., and Ralph W. Phillips, "The Muscle Bone Ratio as an Index of Merit in Beef and Dual Purpose Cattle", Journal of Animal Science, pp. 42-48, February, 1943.

to relate certain live animal measurements to the muscle-bone ratio of the 9th, 10th and 11th prime rib cut, applying this ratio in turn to certain carcass measurements. Although some of the correlations were significant, they were not high enough to be of any practical value.

In 1945, Hankins et al. issued a report[1] in which various linear measurements and weights were used in various combinations in an attempt to find objective measurements for the grading of carcasses. The results indicated that linear measurements are more promising with "weight constant" cattle while measurement-weight ratios are of more value for "weight-variable" cattle. No actual correlation coefficients were given for the various measurements, ratios or indices. However, dressing percent was correlated with carcass grade, and a coefficient of +0.61 was secured.

One of the most important contributions to the study of marketing cattle by carcass weight and grade is the report of the subcommittee of the Canadian Ministry of Agriculture's National Advisory Beef Committee.[2] Pertinent facts in this report will be referred to throughout this thesis.

During World War II packers in the United States did some

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[1]Hankins, O. G., F. J. Beard, and R. L. Hiner, "Measures of Carcass Grade in Meat Animals", The National Provisioner, 112:7, p. 18, February 17, 1945.

[2]Report of the Subcommittee, The National Advisory Beef Committee, "The Practicability of Selling Cattle by Carcass Grade and Weight", Minister of Agriculture, March, 1942.

buying of cattle on a carcass weight and grade basis[1] or on the closely related system of guaranteed yield in order to guard against possible losses which might have been encountered under the war-time price control measures.

An article which appeared in a recent farm magazine briefly summarized the current thinking about this system as applied to hog marketing with the following statement.[2]

> There is no certainty that rail-grading would work in the United States, but certainly there is a great increase in interest on the part of experiment station workers, farmers and packers. It is recognition on their part that something needs to be done to improve the present system of marketing hogs in the United States.

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[1]Project Outline, Cooperative Regional Research Project, North Central States.

[2]Ray, V. G., "Canadian Hogs are Bought on Dressed Value", Successful Farming, 46:3, p.31, March, 1948.

METHOD OF PROCEDURE

To facilitate the collection of data, the cooperation of a commercial packer was secured.

Sampling Technique

Primary consideration was given to the selection of animals which would be representative of all grades of slaughter steers. Only secondary interest was given to either weight or age groups. Plans called for the use of approximately 10 lots of from 5 to 30 head each, but because of the difficulty of purchasing small lots at the time the study was conducted, some larger lots were used. There seems to have been no adverse effects caused by the use of larger lots except that there was difficulty in getting individuals in all of the different grade groups. Six lots of from 10 to 34 head were actually used in the study.

In order to adequately sample the different grade groups, data were to have been secured on approximately 200 steers. This number was considered to be adequate for any correlation purposes which might be desired later. The impracticability of securing steers in the low commercial, high and average utility grades because of the favorableness of the pasture season, the high price of feeder cattle, the pressure of consumer resistance to high meat prices and other factors relative to conditions during the study period made it possible to secure data on only

141 individual steers. One carcass was condemned, thus reducing the number sampled to 140.[1] An attempt was made to select fairly uniform lots so that all grades would be represented, the larger percentage of the animals falling in the commercial and good grade.

Table 1. Number and percentage of carcasses in each government grade.

Grade	: Number	: Percentage
Choice:	2	1.4
High choice	0	.0
Average choice	1	.7
Low choice	1	.7
Good:	70	50.0
High good	14	10.0
Average good	16	11.4
Low good	40	28.6
Commercial:	42	30.0
High commercial	21	15.0
Average commercial	20	14.3
Low commercial	1	.7
Utility:	4	2.9
High utility	0	.0
Average utility	0	.0
Low utility	4	2.9
Canner	21	15.0
Cutter	1	.7
Total	140	100.0

[1]For this study, where major emphasis is placed on pricing errors, the loss represented by this carcass would distort the mean price error. However, a condemned carcass represents a loss to the packer which he must distribute over all other purchases. The problem of condemnation merits individual study in a carcass weight and grade system of marketing and will not be undertaken in this thesis.

Plant Procedure

Individual animals were followed through the entire buying, killing and grading process. The necessary marking of an animal for identification was accomplished by the use of a metal tag with one inch numerals on both sides which was inserted into the ear by means of a hog ringer and hog ring. In order to insert the tag, it was necessary to drive the animal into a chute.

Because of the personal element which could easily cause variation among the buyers, only one buyer was used throughout the study. He was asked to estimate the rail grade of the individual animal to the nearest one-third of a grade based on United States government standards, and to estimate the yield to the nearest one-half percent. The actual live weight of the animal was secured at the time of these estimates. The buyer was then asked to estimate the value of the animal to the packer as determined by the carcass grade and weight. Data were recorded on Form I, Appendix A.

The only exception to the packer's customary slaughter methods was that the carcasses were marked individually rather than by lot. This was accomplished by the use of waterproofed manila tags on which the ear tag number was copied. One tag was attached to the brisket of the carcass by a metal clip similar to the ones used by federal inspectors in marking suspect carcasses. This tag remained with the carcass until it was graded on the following day. The other tag, tied to the viscera

near the anus, went with the viscera to the by-products room where the caul and ruffle fat were separated and weighed in individual lots. The metal ear tag remained with the hide until it reached the hide cellar where the hide's weight and grade were recorded according to tag number.

On the killing floor a record was made of all condemnations of carcasses and internal organs and of the weight of all trim for bruises. Also secured was the hot carcass weight, which was later shrunk 2.13 percent in order to determine the cold weight of the carcass. Since it was not practical to reweigh the carcasses in the beef cooler, this shrunk weight was used throughout the study, with the exception of lot 2 for which the actual cooler weight was used.

Data secured in the hide cellar and on the killing floor were kept on Forms II and III, Appendix A.

On the day following slaughter, a government grader from the Production and Marketing Administration branch of the United States Department of Agriculture graded each carcass in accordance with the official government grading standards for dressed beef. The carcasses were graded to the nearest one-third of a whole grade in order to establish a basis for more accurate determination of value. Form IV, Appendix A, was used to record the data.

Additional data secured from the slaughtering plant were the wholesale carcass prices existing at the time of official grading for the various grades and weight groups within grades.

the instructed buying price[1] and the current market quotations for the various classes, grades and weights of hides. Data were entered on Form V, Appendix A.

Before actual analysis was begun, much of the above information on individual animals was transferred to a summary sheet, Form VI, Appendix A. Additional information on the lot was recorded on Form VII.

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[1]Slaughter cattle buyers are ordinarily instructed to buy different grades of cattle on the basis of different so-called "dressed costs", i.e., the cost of the animals to the packer on a dressed weight or carcass basis.

LIMITATIONS

This study was not intended to provide the answers to the many complex questions which can and will arise from the study of this new marketing method. It was an attempt to evaluate the accuracy of the present live weight marketing system and the carcass weight and grade system in reflecting value differences of animals back to the producers.

As this study was proposed, the systems of marketing steers, heifers and cows were to be studied, but because of the loss of time resulting from the March, 1948, strike in the meat packing industry, only the system in relation to steers was evaluated.

Much discussion as to the desirability and practicability of the method has not been included in this thesis because of the limited amount of information available and because of the complexity of those questions in view of the limited facts. On occasion there will be a brief discussion on aspects of questions as they relate to the marketing of steers, but any conclusions or opinions may not be valid for the marketing of heifers or cows.

Market conditions throughout the period of this study were such that the buying price did not always reflect accurately the buyer's estimated value of the animals to the packer. In other words, the number of cattle offered for sale (particularly grain fed cattle) was limited in relation to the demand for well finished dressed beef, and buyers were sometimes instructed to

pay prices above the expected carcass returns in order to satisfy the meat trade. In some instances a packer could lose less money by paying the higher price in order to obtain enough livestock to keep the men profitably employed during the 36-hour work week guaranteed them under the current union contract. This does not mean that the packers were operating at a loss on any particular grade of cattle, however, because this study did not take into consideration the value of by-products and their effect on the animal's value. Lot 2 was the only lot for which the actual price paid was recorded while the appraisal price was used for the other lots.

Government grades were used as the final determinant of the carcass value. Under the assumption that the standards of the official government graders would be uniform, they were employed throughout the study. There was no attempt to substantiate the validity of their interpretation of a given set of subjective standards as to conformation, finish and quality of a given carcass. It should be remembered that even official graders are human beings with varying opinions. In order to control this human element an attempt was made to use only one grader, but because of sickness, vacations and other factors this did not prove to be practical.

Another possible source of limitation was the use of the 1937-1941 average Chicago wholesale price, a historical price, in assigning values to the estimates of grade and yield. This type of price is always subject to criticism. In an attempt to

partially control this limitation, the analysis was repeated, using the wholesale price given by the cooperating packer. This wholesale price was not the actual price for which the given carcass would be sold, but it was the price for which a carcass of corresponding weight and grade would have sold on the day of official grading. Even though the use of historical prices is criticized they are not worthless. The comparison of the analysis using historical prices with the analysis using current prices is of considerable value.

One limitation of the historical price series is the artificial division of the price for each full U. S. grade into thirds. This was accomplished in the following manner. The five-year average price at Chicago for each full grade was computed from the Chicago Daily Market Report of the United States Department of Agriculture. The average price for the full grade was assigned to the middle one-third grade while the prices for the upper and lower one-third grades were adjusted by one-third of the spread between grades.

The wholesale price of the cooperating packer is also subject to the same criticism except that an actual price differential does exist between high good and average good and between high commercial and average commercial. However, there is no differential between average good and low good nor between average commercial and low commercial. Therefore, if a buyer would judge an animal to be of an average good grade and the carcass would later be officially graded low good, there would be no

difference in the packer's wholesale price. The fact that some commercial slaughterers have recognized a difference in the carcass's value to the consumer between high commercial and average commercial and between high good and average good is some indication that there may be a need for the revision of the present government grading standards. Although this study does not attempt to prove this fact, it should be recognized as a limitation.

The effect of human reaction to the profit motive is another limiting factor which warrants some discussion. The packer buyer's purchases must average out over a period of four to five weeks in order for him to retain his position. Human nature is such that a person will attempt to buy at as low a price as possible. No attempt is being made to defend the packer buyer's action but rather to objectively state the situation. However, if at times a buyer tends to underpay because of this human element, there are many other factors such as errors in judgment, market conditions and personal opinions that may cause over-payment on other occasions.

It also should be pointed out that the price paid by the buyer does not necessarily represent his judgment of the cattle's worth. Buying livestock is a matter of trading. If the buyer needs the livestock, it is quite possible he will pay more than it is worth. On the other hand, if the seller is more anxious to sell his livestock than the buyer is to buy, it is quite possible that the buyer will pay less than the livestock is actually worth

on the market. And, of course, each transaction is an individual transaction, one seller being more anxious to sell his livestock than another offering cattle of similar quality and grade.

ANALYSIS AND INTERPRETATION

Dressed beef is commonly priced in the wholesale trade on the basis of grade standards which are either set up by the United States Department of Agriculture or by the individual packer. Packer grades are usually designated by brand name or by number. Regardless of which type of grade is used, each grade is given a value. The objective of this analysis was to determine if a carcass's value to the packer is accurately reflected back to the producer under the present marketing system based on live weight.

In their purchasing of cattle, buyers do attempt to arrive at the actual value by the estimation of the carcass grade and yield. It appears to be evident that one approach to the above objective is the analysis of these estimates made by the buyer. A brief summary of the method is found in an article by Gerald Engelman, who said,[1]

> More precisely, this analysis concerns the departures of these estimates from the actual yield as determined from the carcass weight, and the actual grade as determined by the government grader. These departures represent the substance of the buying errors. In their analysis, they can be subjected to the usual measures of dispersion.
>
> Yield and grade, however, are strictly physical concepts and the measures of dispersion thus will, of course, be expressed in physical terms. The economic analysis begins when the prices are assigned the various carcass

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[1]Engelman, Gerald, "Carcass Grade and Weight Studies in Marketing Livestock", Journal of Farm Economics, 29:4, Part II, p. 1425, November, 1947.

> grades. It then becomes possible to compare the estimated price of the animal with the actual value as determined by the weight and grade of the carcass. Through the use of the dispersion analysis the probabilities of the price paid being within any given set of prescribed limits of the actual value can readily be determined. Furthermore, the price error thus can be broken down into its component parts, the portion due to errors in estimating yield and the portion due to errors in estimating grade. By calculating the dispersions of each separately, the relative contribution of each to the total price error can be measured.

The discussion of the analysis procedure will be undertaken in the following order. The dispersion of the two physical errors, grade and yield, will be considered first. Prices will then be assigned to the various grades in order to determine the total price error. When this total price error is divided between errors in price and errors in yield, the contribution of each can be measured. The probable occurrence of a certain price error will then be determined.

The following general information about the lots should be given before entering into a discussion of the buying errors. All lots used in the study were direct purchases. A high percentage of the animals in lots one to five were of Hereford breeding while lot six was composed of steers of mixed dairy breeding. Lots one to five had been fed in a dry lot and lot six had been on pasture. The estimated and actual grade and the yield for each lot is summarized on Table 2.

The average lot grades, both estimated and actual, were calculated in the following manner. In order to determine the average lot grade, each one-third of a full grade was assigned a successive number, starting with grade AA 1 as number 1. The

number of animals in each one-third grade was multiplied by the number assigned to that division of a grade. The sum of these products was divided by the number of animals in the lot. The arithmetic average obtained was referred back to the arbitrary number in order to determine the average grade for the lot. The mode and median were also obtained in order to check the arithmetic average. In all cases the three averages were the same. It must be realized that this was a somewhat artificial method of obtaining a lot grade, but this crude calculation was sufficient for the desired purpose of comparison. The average estimated yield of a lot was equal to the sum of the individual yield estimated divided by the number of steers in a lot, while the actual yield equaled the total of all individual carcass weights divided by the total weight of the lot. Table 2 illustrates how the buyer overestimated grade and underestimated yield.

Table 2. Estimated and actual grade and yield for all lots.

Lot no.	No. head	Grade			Yield		
		Estimated	Actual	Diff.	Estimated	Actual	Diff.
1	10	A 2	A 3	+ 1/3	58.0	59.2	- 1.2
2	20	A 3	A 1	- 2/3	55.7	59.3	- 3.6
3	34	A 3	B 1	+ 1/3	58.6	59.0	- 0.4
4	17	A 2	A 3	+ 1/3	57.9	59.6	- 1.7
5	33	A 2	A 3	+ 1/3	58.2	59.4	- 1.2
6	26	C 2	D 1	+ 2/3	49.8	51.7	- 1.9

The buyer was able to give a fairly accurate estimate as to the whole grade in which a lot would fall, but it was more diffi-

cult for him to place a lot in the finer divisions of the grade. The buyer's tendency to overestimate grade and underestimate yield would tend to average out any price errors made on a group of lots, but the producers of the individual lots may have either suffered or gained by these errors.

Although the different weight groups were given only secondary interest in the selection of animals, live weight classification was not entirely omitted. It was felt that there would be a fairly representative sample by live weight groups within the total without taking samples from certain weight groups. However, if a larger total of steers had been used, it would have probably become necessary to sample within certain weight groups. The classification of steers by carcass grade and live weight is shown in Table 3. This table shows that all weight classifications were adequately sampled, with the exception of the 1,000 pounds and over group of heavy steers.

Table 3. Number of animals classified by carcass grade and live weight.

Live weight	Total	Government grade															
		AA			A			B			C			D			E
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1
501-600	2												1				1
601-700	20				1	2	4	1	4	1			1	5		1	
701-800	46		1		7	3	16	2	4				2	11			
801-900	40			1	3	7	11	8	6					4			
901-1000	26				2	3	7	8	6								
1001 & over	6				1	1	2	2									
Total	140		1	1	14	16	40	21	20	1			4	20		1	1

During the course of this study no attempt was made to control the time interval between the weighing and slaughtering processes. The length of time between weighing and slaughtering for lots 1 through 4 was approximately 24 hours while there was only a two-hour period for lots 5 and 6. Whether or not this time element had any effect on yield was not determined.

In accordance with customary procedures, the carcasses were allowed to hang on the rail for approximately 24 hours prior to grading.

A rough estimate was made of the time taken to tag, weigh and make estimates. A crew of four men could perform these operations on approximately 24 to 30 steers per hour.

Dispersion of Grade Errors

Dispersion of errors in the estimation of grade can be studied only in the comparison between live grading and carcass grading in accordance with the standards set up by the United States Department of Agriculture. Table 4 presents an analysis of the relationship existing between the live grading of the packer buyer and the carcass grading of government graders.

This table shows that there was considerable disagreement between estimated grade and actual carcass grade. The buyer's tendency to buy on averages is again shown. The buyer's difficulty in the selection of top grade animals in the yards is also evident. The percentage of identical classification was 21.4

Table 4. Analysis of relationship between estimated grade and government grade.

Esti-mated grade	Total	Government grade: AA 1	AA 2	AA 3	A 1	A 2	A 3	B 1	B 2	B 3	C 1	C 2	C 3	D 1	D 2	D 3	E 1
AA 1																	
AA 2																	
AA 3	2						1	1									
A 1	15		1		4	4	4	2									
A 2	51			1	4	10	25	7	4								
A 3	27				4	2	6	9	6								
B 1	13				2		3	1	6	1							
B 2	5						1	1	3								
B 3	2								1				1				
C 1	1													1			
C 2	13												2	11			
C 3	1												1				
D 1	3													3			
D 2	5													5			
D 3	1															1	
E 1	1																1
Total	140		1	1	14	16	40	21	20	1			4	20		1	1

percent. The correlation coefficient was .894. The results of a similar study conducted in Canada are quoted below.[1]

> The table indicates that live grading is not consistent with carcass grading. If carcass grading is considered the correct measure of quality, then the present method of buying cattle according to live grades has little to merit its continuation. Cattle are mostly purchased in carload lots and in many cases live grades are not the measure of price, but in general uniformity, quality and finish are considered by the buyer and his judgment is the determining factor...despite the great experience of most cattle buyers, their judgment of live cattle is not consistent in relation to carcass grading. In view of this situation there would naturally be a tendency for the buyer to under-grade cattle when buying them rather than to over-grade.

Table 5. Analysis of buyer's estimate of carcass grade.

Deviation of estimate from official grade. + or -	Total	Government grade															
		AA			A			B			C			D			E
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1
4/3	1							1									
3/3	9						1	2	4				1	1			
2/3	29						4	7	6	1				11			
+ 1/3	46					4	25	9	6				2				
0	30				4	10	6	1	3				1	3		1	1
- 1/3	16				4	2	3	1	1					5			
2/3	7		1	1	4		1										
3/3	2				2												
Total	140		1	1	14	16	40	21	20	1			4	20		1	1

[1]Report of the Subcommittee, The National Advisory Beef Committee, op. cit., p. 4.

It is shown by Table 5 that the buyer was within one-third of a government grade 65 percent of the time and within two-thirds of a grade 84 percent of the time. The buyer's estimates were above the government grade 60.7 percent of the time and below 17.8 percent. The buyer's difficulty in estimating the probable carcass grade of the live animal is also shown.

Since most of the beef sold by the cooperating packer is graded by a packer representative in accordance with grades established by the packer instead of by those set up by the government, the relationship between the estimated grade and the packer grade should be studied. The grading standards of the cooperating packer were similar to government standards with a few exceptions. The grade, U. S. good, was divided into two grades under the packer's system. In the terminology of this study, high good becomes one grade while low and average good are combined to make another. The same thing was done for the U. S. commercial grade.

The relationship between the buyer's estimated grade and the packer grade is shown in the following tables.

Table 6. Analysis of relationship between estimated grade and packer grade.

Estimated grade	Total	Packer grade							
		AA	A		B		C	D	E
			1	2 & 3	1	2 & 3			
AA	2			2					
A 1	15	2	7	6					
A 2	51	3	23	20	5				
A 3	27		7	19	1				
B 1	13		3	3	7				
B 2	5			3	2				
B 3	2				1		1		
C 1	1						1		
C 2	13						10	3	
C 3	1						1		
D 1	3						1	2	
D 2	5							5	
D 3	1							1	
E 1	1								1
Total	140	5	40	53	16		14	11	1

Table 7. Analysis of buyer's estimate of grade compared to packer grade.

Deviation of estimate from packer grade, + or -	Total	Packer grade							
			A		B				
		AA	1	2 & 3	1	2 & 3	C	D	E
	3/3								
	2/3	10		2	5			3	
+	1/3	8		6	1		1		
	0	74	7	39	7		12	8	1
-	1/3	31	2	23	3	2	1		
	2/3	14	3	7	3	1			
	3/3	3		3					
Total		140	5	40	53	16	14	11	1

The two preceding tables show that a much closer relationship existed between the buyer's estimate and the packer grade than between the buyer's estimate and the government grade, but that there was still error in the buyer's judgment of grades. In the analysis shown in Table 6 the percentage of identical classification was 53 percent in comparison to the 21.4 percent in the analysis of Table 4. Also, 78.5 percent of the buyer's estimates were within one-third of a grade and 98 percent were within two-thirds of a grade as compared with Table 5 where the percentages were 65 and 84, respectively. The correlation coefficient for Table 6 was 0.875 as compared with 0.894 for Table 4. Because of the greater percentage of identical classification in Table 6, it was expected that the coefficient of correlation would be greater also. This was not the case. A possible explanation for this is that the heavy weighting of the extreme values in Table 4, because of the greater number of grade classifications, caused the

correlation coefficient of that table to be larger than for Table 6. The estimates were above the packer grade 12.9 percent of the time and below 34.3 percent.

Since the buyer's estimate of carcass grade was compared with both the government grade and the packer grade, it was convenient to make a comparison between grading as done by the packer grader and as done by the government graders. This was accomplished in Table 8, using the same packer grades as defined for Table 6.

Table 8. Analysis of relationship between packer grade and government grade.

Packer grade	Total	Government grade															
		AA			A			B			C			D			E
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1
AA	5		1	1	3												
A 1	40				11	12	16	1									
A 2 & 3	53					4	22	17	10								
B 1	16						2	3	10	1							
B 2 & 3																	
C 1 - 3	14											4	10				
D 1 - 3	11												10		1		
E 1	1																1
Total	140		1	1	14	16	40	21	20	1		4	20		1		1

Considerable disagreement between the two grading systems is shown in this table. For instance, of the 21 steers which were placed in the low and average commercial grade by government graders none was placed in the corresponding packer grade. Since only one packer grader was used during the study, there may have been a lack of consistency in grading by the four government

graders.

Table 9. Analysis of packer grades compared to government grades.

Deviation of packer grade from gov. grade + or -	Total	Government grade															
		AA			A			B			C			D			E
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1
	3/3	1						1									
	2/3	27					16		10	1							
+	1/3	52			3	12		17	10					10			
	0	58		1	1	11	4	22	3					4	10		1	1
-	1/3	2						2									
	2/3																
	3/3																
Total		140		1	1	14	16	40	21	20	1			4	20		1	1

The preceding table shows that there was agreement on 41.5 percent of the carcasses. The packer grades were higher than the government in 57 percent of the cases and lower in only 1.5 percent. This would indicate that there is considerable disagreement between the government and commercial trade as to what constitutes an A or B carcass. The Canadian subcommittee made the following statement about the relationship which existed in their study between packer grading and government grading.[1]

> The study indicates a close relationship between the grading done by the packer grader and the official grader. They agreed on standards in 85 percent of the carcasses graded...It would appear from the data when studied by periods that there is a gradual improvement in the consistency of the grading as time goes on, and that the

[1]Report of the Subcommittee, The National Advisory Beef Committee, op. cit., p. 5.

percentage in which there is agreement continually increases rather than fluctuates.

Tables 8 and 9 indicate that there is a need for more definite empirical standards for the various carcass grades in order to improve the relationship now existing between the cooperating packer and U. S. government standards.

Dispersion of Yield Errors

Yield is the second source of buying errors. Under conditions existing in the slaughter industry, this factor is assumed to be of more importance to the packer than is grade because it can be more easily measured. Therefore, for the purposes of this study, yield estimates were subjected to the same tests which were used for grade estimates. Table 10 illustrates the relationship which existed between the yield estimates and actual yields.

The considerable error in the buyer's estimate of an individual animal was partly due to the fact that under the present system, the buyer ordinarily makes his estimate on a lot rather than on individual animals. It is only natural for a buyer not to be concerned with individual yields since all beef tests conducted by the packer as checks on the buyer's purchases are made on a lot basis. Yet, yield is such an important determinant of the purchase price of cattle that any inaccuracies on the buyer's part in estimating yield may mean either a loss or gain to the individual producer. The dispersion of errors in the estimation of yield is shown in Table 11.

Table 10. Analysis of the relationship between estimated yield and actual yield.

Esti. yield	No. head	Actual yield 49.0	49.5	50.0	50.5	51.0	51.5	52.0	52.5	53.0	53.5	54.0	54.5	55.0	55.5	56.0	56.5	57.0	57.5	58.0	58.5	59.0	59.5	60.0	60.5	61.0	61.5	62.0
47.0	1			1																								
47.5																												
48.0	1					1																						
48.5	1						1																					
49.0	7	1	1	1	1	2		1																				
49.5	1					1																						
50.0	6		1		1		2	1	1																			
50.5																												
51.0	7				1		3	1	1			1																
51.5	1						1																					
52.0	1									1																		
52.5																												
53.0																												
53.5																												
54.0	1												1															
54.5																												
55.0	6													1		3		1										1
55.5	4														1				3									
56.0	3															2			1									
56.5	3																1								1	1		
57.0	5													1	1	1			1	1								
57.5	11														2	1		1	2	2		1	1	1				
58.0	43											1			1	1		6	3	3	4	7	5	9	2	1		
58.5	17																		2	3	3	3	2	2	1	1		
59.0	15																2			2	2	3		1	3		1	1
59.5	3													1									2					
60.0	3																					2				1		
Total	140	1	2	2	1	2	4	7	3	2	1	1		1	2	3	5	9	8	13	11	18	13	14	8	5	2	2

Table 11. Analysis of buyer's estimate of carcass yield by grades.

Deviation of estimated from calculated yield + or -		Total	Government grade														
	Mid-		AA			A			B			C			D		E
Range	point		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1
3.3 - 3.7	3.5	1								1								
2.8 - 3.2	3.0																	
2.3 - 2.7	2.5																	
1.8 - 2.2	2.0	5						2	2	1								
1.3 - 1.7	1.5	1								1								
0.8 - 1.2	1.0	2					1			1								
0.3 - 0.7	0.5	12					2	4	4	1						1		
-0.2 - 0.2	0.0	12					2	4	2	2						2		
-0.3 --0.7	-0.5	15					1	8	2	3						1		
0.8 - 0.2	1.0	15					1	3	4	2				1		4		
1.3 - 1.7	1.5	18				1	1	5	1	5	1			2		2		
1.8 - 2.2	2.0	16		1		1	2	4	3	1						4		
2.3 - 2.7	2.5	13				2	2	4	1	1				1		2		
2.8 - 3.2	3.0	8				1		3	1	1						1		1
3.3 - 3.7	3.5	10				2	2	2	1							2	1	
3.8 - 4.2	4.0	4				1	2	1										
4.3 - 4.7	4.5	5			1	3										1		
4.8 - 5.2	5.0	1				1												
5.3 - 5.7	5.5	1				1												
5.8 - 6.2	6.0																	
6.3 - 6.7	6.5																	
6.8 - 7.2	7.0																	
7.3 - 7.7	7.5	1				1												
Total		140		1	1	14	16	40	21	20	1			4	20		1	1

The percentage of correct buyer's estimates was 8.5 percent, while 14.3 percent were too high and 76.2 percent were too low. Psychologists state that underestimation and overestimation are common characteristics of the human race, the situation deciding which will prevail. Experienced cattle buyers will admit that it is next to impossible to correctly estimate either yield or grade. It is only natural for a buyer to underestimate in order to avoid losses. Therefore, a buyer should not be too severely criticized for underestimating yield without first evaluating the live weight system of buying under which he must work.

The variation of yield among the different grades and the variation of yield among animals of the same grade are shown in the following table.

Table 12. The average yield and range in yield by grade.

Grade	Number of head	Average yield	Range
A 1	14	60.46	58.4 - 62.5
A 2	16	59.18	56.2 - 62.3
A 3	40	59.16	56.6 - 61.8
B 1	21	59.24	57.1 - 61.0
B 2	20	58.55	54.5 - 61.1
D 1	20	51.57	49.0 - 55.4

The mean yield was calculated for only those grades in which there were sufficient individuals. It is shown in this table that it would be impossible to use the mean yield as a basis of establishing grades because of the considerable variation within a grade which is indicated by the overlapping ranges. No attempt

was made in this study to control "fill" or any other factor affecting yield. The Canadian subcommittee reported the following findings on this subject.[1]

> ...it might be assumed that a definite dressing percentage could be established for each of the grades and cattle sold accordingly. This assumption is not a correct one and would be detrimental to the producer because there is such a variation in dressing percentage within each grade...If the mean dressing percentages were established as a standard for the grade for each group it woul accurately apply only to a small proportion of the animals... Thus the adoption of the mean dressing percentage as a standard would not be satisfactory and would unfairly discriminate against the producers of high quality animals with higher than average dressing percentages.

Other findings reported by the Canadian subcommittee which are relevant to yield are as follows.[2]

> Quality and condition of cattle are more important than the number of hours of shipping cattle from different points to the market. The time of holding cattle in the yards before slaughter would not interfere with any such policy, as in carrying period from 24 to 95 hours of holding cattle, the dressed carcass weight would show no loss. After a period of 95 hours of holding cattle (which is unusual) a policy of adjustment in weight on a percentage basis similar to the present system of marketing hogs could be adopted.

Dispersion of Price Errors

The economic analysis began with the assignment of prices to the various carcass grades, thus making it possible to compare the estimated price as determined by the estimated grade and

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[1]Report of the Subcommittee, The National Advisory Beef Committee, op. cit., p. 6.

[2]Report of the Subcommittee, The National Advisory Beef Committee, op. cit., p. 13.

yield to the actual value as determined by the actual grade and yield. The dispersion of price errors was determined by the familiar statistical technique, standard deviation.

The two price series used throughout the remainder of this study were the historical series and the current series, the first of which appears in Table 13.

The current price series was composed of the current wholesale price for each grade and weight group as it was quoted by the cooperating packer on the day of official grading.[1] The two price series were used in order to establish a means of comparison between the prices of a current period and prices in a period which is often referred to as normal.

The relationship between estimated and calculated live price using each of the two price series is shown in Tables 14 and 15.

The information and computations used to determine the calculated and estimated live price, total error, grade error and yield error for all lots are shown in Appendix B. The sum total of all lot errors was divided by the number of lots in order to obtain the mean total error, mean yield error and mean grade error per lot. These results are shown in Table 16.

Table 16 shows that the mean total error based on the estimated grade and yield and on the current price favors the packer by 37 cents. However, this does not necessarily mean that the packer is buying cattle at prices lower than their carcass

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[1]See Form V, Appendix A.

Table 13. Wholesale prices, steer and heifer carcasses at Chicago, 1937-1941.[1]

Official carcass grade		Quoted price 1/ (dollars)	One-third grade	Price for one-third grade 2/ (dollars)
Choice	(AA)	17.76	AA 1	18.30
			AA 2	17.76
			AA 3	17.22
Good	(A)	16.13	A 1	16.67
			A 2	16.13
			A 3	15.44
Commercial	(B)	14.36	B 1	14.95
			B 2	14.36
			B 3	13.88
Utility	(C)	12.93	C 1	13.40
			C 2	12.93
			C 3	12.46
Cutter	(D)	10.74	D 1	11.05
			D 2	10.74
			D 3	10.52
Canner	(E)	10.09	E 1	10.32
			E 2	10.09
			E 3	9.88

1/ Source - USDA.

2/ Price for middle one-third grade is the reported price for the full grade. Prices for upper and lower one-third grades were adjusted by one-third of the spread between grades.

[1]Project Procedure, Cooperating Regional Research Project, North Central Livestock Marketing Research Committee.

Table 14. Analysis of relationship between estimated live price and calculated live price per hundredweight. Historical price series.

Estimated price 1/	Total	Calculated live price 2/ (by half-dollars)									
		5.00	6.00	7.00	8.00	9.00	10.00				
4.50	1	1									
5.00	7	1	6								
5.50	1		1								
6.00	10	2	6		2						
6.50	6		4	2							
7.00	1				1						
7.50	1						1				
8.00	11					5		3	2	1	
8.50	28					1	4	10	8	1	4
9.00	50						2	16	21	7	4
9.50	21						1	7	7	2	4
10.00	3							1	1	1	
Total	140	4	17	2	3	1	12	35	40	13	13

1/ $\frac{\text{Estimated yield}}{100} \times \text{Carcass price per hundredweight for the estimated grade.}$

2/ $\frac{\text{Carcass weight}}{100} \times \frac{\text{Carcass price per hundredweight for the actual grade.}}{\text{Live weight}}$

Table 15. Analysis of the relationship between estimated live price and calculated live price per hundredweight. Current price series.

Esti. price 1/	Total	Calculated live price 2/ (by half dollars)																												
		19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00	30.00	31.00	32.00	33.00	34.00													
		.00	.50																											
18.50	1		1																											
19.00	2			2																										
19.50	5		1	1	2	1																								
20.00	2				2																									
20.50																														
21.00	3		1	1	1																									
21.50	12		1	1	4	2		2	1				1																	
22.00	4						1			1	1			1																
22.50	1							1																						
23.00																														
23.50	7						1	1		1	3			1																
24.00	13					1	2	3		3	3			1																
24.50	5			1				1				1	2																	
25.00																														
25.50	1					1																								
26.00																														
26.50																														
27.00																														
27.50	2							1		1																				
28.00	3							1		1			1																	
28.50	1										1																			
29.00	1									1																				
29.50	5									1	1			1	1	1														
30.00	9							1	1	1	2			1	1	2														
30.50	18									1	1		2	5	3	2	1	2	1											
31.00	15											2	1	2	2	2		2	3	1										
31.50	20						1		1	1		1	2		1		1	2	2	4	3	1								
32.00	9																1	1	2	3	1	1								
32.50																														
33.00	1													1																
33.50																														
Total	140	4	3	11	4	2	2	2	3	4	3	4	5	4	1	9	2	6	6	4	3	9	7	7	7	8	10	7	2	1

1/ $\frac{\text{Estimated yield}}{100} \times \text{Carcass price per hundredweight for the estimated grade.}$

2/ $\frac{\text{Carcass weight}}{100} \times \frac{\text{Carcass price per hundredweight for the actual grade.}}{\text{Live weight}}$

value, because the price used is an estimated one rather than actual. The actual price paid was not used in the study, and this table should pe interpreted accordingly.

With the finer breakdown of grade brought about by the use of the historical price series, the mean total error was zero. Thus, total purchases tended to average zero over a group of lots even though errors did exist for individual lots.

Table 16. The mean total error, mean yield error and mean grade error per lot per hundredweight.1/

Price series	Mean error (in dollars)		
	Total	Yield	Grade
Current	- .37	- .77	.40
Historical	.00	- .25	.25

1/ Taken from Table 24, Appendix B.

Table 16 also indicates that with current prices, price errors in estimating yield were greater than those in estimating grade. Using historical prices, price errors in estimating yield are equal to those made in estimating grade.

The three mean errors for all individual animals were calculated by dividing the sum of the individual total errors, the sum of individual grade errors and the sum of individual yield errors, each by the total number of individuals. The method of obtaining the three errors for each individual is shown in Appendix C.

Using the current price, the average total error per hundredweight per head was a minus 17 cents, the errors in the

yield estimates being greater than those in the grade estimates. Using the historical series, price errors in the estimation of grade were greater than those which were made in the estimation of yield. Both Tables 16 and 17 show that yield was underestimated and grade overestimated.

Table 17. The mean total error, mean yield error and mean grade error per individual per hundredweight.1/

Price series	Mean error (in dollars)		
	Total	Yield	Grade
Current	- .17	- .69	.51
Historical	.06	- .22	.28

1/ Taken from Table 25, Appendix C.

The mean errors per individual were computed for the grades in which there were sufficient individuals. This was accomplished by grouping all individuals of a certain grade and following the analysis method outlined in Appendix C. Only the current price series was used. The results of this analysis are shown in the following table.

Table 18. The mean total error, mean yield error, and mean grade per head in hundredweight by carcass grade.

Carcass grade	Mean error (in dollars)		
	Total	Yield	Grade
A 1	- 2.30	- 1.70	- .60
A 2	- .64	- .90	.20
A 3	- .75	- .62	- .19
B 1	.64	- .38	1.02
B 2	1.94	- .23	2.15
D 1	.20	- .72	.93

The preceding table shows that both grade and yield were underestimated on A 1 carcasses, and that grade was overestimated while yield was underestimated for B 2 carcasses. This emphasizes the conclusions reached in the section on grading that it is difficult to accurately judge quality in the live animal. Estimates of yield caused the greatest error for the higher grades while grade estimates were the greatest source of error in the lower grades.

The variance and standard deviation were computed for all mean errors shown in Tables 16, 17 and 18 in order to get some measure of the variability of the errors. Theoretically, all buying errors should be zero for this study. Therefore, the deviation of the errors was measured from zero rather than from the mean error. The variance of the mean errors for the lot was calculated by dividing the sum of the squares of the lot errors by the total number of lots. The variance of the mean errors for all individuals was calculated by dividing the sum of the squares of the individual errors by the number of individuals. The variance of the individual mean errors for each grade was computed by dividing the sum of the squares of the errors for all individuals in each grade by the number of individuals in the same grade. The standard deviation was computed for all classifications by obtaining the square root of the variance. The variance and the standard deviation are shown in the following table.

Table 19. The variance and standard deviation for all mean errors of Tables 16, 17 and 18.

Source of error, price series and grade	Variance of mean errors			Standard deviation of mean errors		
	Total	Yield	Grade	Total	Yield	Grade
Mean, all lots:						
Current	.9839	.7543	.4696	.992	.869	.685
Historical	.2042	.0878	.1554	.452	.296	.394
Mean, all individuals:						
Current	2.7912	1.1026	1.7852	1.675	1.050	1.337
Historical	.4090	.1168	.3080	.639	.342	.555
Mean, all individuals by grade:						
Current						
A 1	6.4175	3.2165	.8099	2.535	1.795	.899
A 2	1.4579	1.3678	.3674	1.207	1.170	.606
A 3	1.4552	.8453	.3977	1.205	.919	.631
B 1	1.8655	.7125	1.0122	1.369	.844	1.005
B 2	6.4966	.6906	6.8870	2.548	.831	2.625
D 1	.9011	.7964	1.4442	.949	.892	1.202

By comparing the variance of yield to the variance of grade, it can be determined which of the estimates was the greater cause in the variance of the total error. When current prices were used, the variance of the mean yield error per hundredweight per lot was nearly twice as important as the mean grade error in causing the variance of the mean total error per lot. However, with the use of historical prices, the variance of grade is of nearly twice the importance of the variance in yield in causing the variance of the mean total error. This difference in the important error was attributed to the assignment of a value to the low commercial and low good grades when using historical prices.

Since only six lots were used in the computation of the mean errors per lot and the standard deviation of those errors, it was recognized that their validity as estimates of the population mean and standard deviation was very limited. However, the number of individuals was sufficiently large so that it could be assumed that the mean errors per individual and their respective standard deviations were valid estimates of the population mean and standard deviation.

Another source of limitation of the mean errors per lot was the unequal number of animals per lot. This unequal weighting may have resulted in biased mean errors. No attempt was made to equalize the weighting of the individual lots and thus, to check the mean errors.

Percentage Contribution

In making his estimates of yield and grade, the buyer does not consider them independently. Since they are mutually dependent, they are subject to interaction. With the variance and the standard deviation known, it was possible to measure the interaction between the grade and yield estimates by the following formula, the standard error of a sum:

$$\sigma_T^2 = \sigma_g^2 + \sigma_y^2 + 2r\,\sigma_g\,\sigma_y$$

By solving for the correlation coefficient, "r", a measure of interaction was obtained. By the use of the same equation, it was also possible to measure the relative contribution of

each of the estimates and of the correlation between them to the total price error. The correlation and the percentage contribution of each component of the total error are shown in the following table.

Table 20. The percentage contribution of grade and yield to the total price error and correlation of grade and yield.

Source of error, price series and grade	Percentage contribution: Yield	Grade	Yield X grade	Correlation r_{GY}
Mean, all individuals:				
Current	39.5	64.0	- 3.5	- .0347
Historical	28.6	75.3	- 3.9	- .0415
Mean, all lots:				
Current	76.7	47.7	- 24.4	- .2016
Historical	43.0	76.1	- 19.1	- .1672

Careful interpretation must be made of this table because of the negative correlation. For example, the first entry in the table was interpreted in the following manner:

The contribution of grade estimates to the total error was 1.6 times more important than the estimates of yield. However, it cannot be said that 64.0 percent of the total error was caused by wrong grade estimates. Since the association of the two constituent errors was negative, some unknown portion of the interaction must be subtracted from 64.0 before the actual contribution of grade to the total error can be known. With a negative association between the yield and grade errors, it was impossible to determine the exact contribution of each estimate to the total

error. Therefore, the only value of this table was the comparison between the percentage contributions of grade and yield.

The non-significance of the interaction in Table 20 indicates that the correlation or dependence between the estimates of grade and yield was not sufficiently strong to become apparent.

Because of the small numbers within any grade grouping, no attempt was made to measure the proportional contribution of the two errors within the various grades.

Probability of Specified Price Errors

Assuming that the number of individuals was sufficiently large so that the standard deviation obtained was a valid estimate of the population standard deviation when the mean was zero, it was possible to determine the probable occurrence of a specified price error.

Table 21. The probable occurrence of a specified price error for all individuals, using current prices.

Error from actual price + or -	Probability of price error less than the specified price error (percent)
.25	11.86
.50	23.46
.75	34.56
1.00	44.94
1.25	54.46
1.50	62.94
1.75	70.38
2.00	76.76
2.50	86.44
3.00	92.68
3.50	96.34
4.00	98.30
4.50	99.28
5.00	99.72

This table indicates that for all individuals the price per hundredweight will be within a range of 25 cents above or below the actual value of the respective animals 11.86 percent of the time. The probability of the price being outside of this 50 cent range is 88.14 percent.

Table 22. The probable occurrence of a specified price error for all individuals, using historical prices.

Error from actual price + or -	Probability of price error less than the specified price error (percent)
.10	12.44
.20	24.56
.30	36.12
.40	46.88
.50	56.60
.60	65.22
.70	72.66
.80	78.96
.90	84.10
1.00	88.24
1.25	94.96
1.50	98.12
1.75	99.38

This table is interpreted in the same manner as the preceding table. In the selection of the price intervals to be used in each table, an attempt was made to select intervals which would be representative of day to day price rises or declines in the period in which the prices were based. Ten cents was a common daily increase or decrease in livestock prices for the years 1937 to 1941. Under present conditions, it is not uncommon to have prices change a quarter or more from day to day. At times, a

change of one dollar is not uncommon. As the size of the price error increased, the probability of its recurrence increased at a diminishing rate. Therefore, price intervals of 10 and 25 cents were not used consistently in the tables.

The standard deviation of the individual mean total error, using current prices, was divided by the square root of ten to obtain the standard deviation of the individual error for a lot of 10 head. This made it possible to calculate the probability of a certain price error per hundredweight for a lot of that size.

Table 23. The probable occurrence of a price error less than the specified price error for a lot of 10 head. Current prices.

Error from actual price + or -	Probability of price error less than the specified price error (percent)
.25	36.28
.50	65.46
.75	84.30
1.00	94.08
1.25	98.18
1.50	99.54

This table shows that the probability of a price error less than 25 cents above or below the actual price per hundredweight for a lot of 10 head was 36.28 percent. The price error for the lot will be greater than 25 cents 63.72 percent of the time.

A table similar to the one above can be calculated for any given size of lot by dividing the standard deviation for all individuals by the square root of the particular lot size desired.

A similar table for the lot mean total error also can be calculated when the number of lots is sufficiently large to assume that the standard deviation of the lots is a valid estimate of the population standard deviation.

It also would be possible to calculate the probable occurrence of a certain price error when the mean error for all individuals was biased in either direction as it was in this study. If this were done for mean total error for all individuals using current prices obtained in this study, the probability of a minus 25 cent price would be smaller than the probability of a plus 25 cent price error.

Dispersion of Error "X"

Another pricing error exists because of the use of the appraisal price in the estimation of the actual value of an animal to the packer. The appraisal price may be defined as the price for which an animal would be purchased if all unusual factors such as strong demand against short supply were disregarded.

The appraisal price per hundredweight was compared with the estimated live price. The resulting difference was called error "X". The same dispersion analysis used on the other pricing errors was used on this error with the results appearing in Table 24.

Table 24. The mean, variance and standard deviation of error "X".

Source of error	Mean	Variance	Standard deviation
All individuals	1.72	2.1240	1.46
All lots	1.73	1.7209	1.31

It was not possible to definitely determine the meaning which should be attached to this error. It would appear that the packer was paying more for the animals than their actual worth because the positive error of error "X" more than offsets the negative errors of Tables 16 and 17. However, if this were true, the packer would be unable to remain in business.

For error "X" the standard deviation was measured about the mean rather than about zero as was done for the other price errors.

VARIABILITY OF CERTAIN BY-PRODUCTS

The value of by-products was not considered in the estimated and calculated live price. Although by-products are of value to the packer, it was not within the scope of this thesis to study the effect of their worth on carcass value. Part of Engelman's discussion of by-products' value is quoted below.[1]

> Although the major emphasis in studies of this type is properly placed upon the carcass and its value, it must be remembered that the carcass does not constitute the entire value of the slaughter animal. Another broad area of investigation is an analysis of the by-products from the slaughtering process. Of these the most important are the hide in cattle and calves and the pelt in lambs. The composite value of these and other by-products generally exceeds the cost of slaughtering and thus provides an incremental value above that of the carcass alone...Since the value contribution of these by-products, particularly the internal fats and edible organs, might vary considerably by grade, weight and sex of the animal, there would be considerable merit, therefore, in determining the approximate yields of the various by-products in order that differential credits by grade, and possibly by sex, can be calculated.

In the course of this study, weights of hides and oleo fats were secured. Although preliminary studies were conducted on the variability of hide weight and oleo fats, no conclusions could be reached because of the limited number of animals in any grade group. The variability of hide weight in relation to live weight for all grades containing 14 or more individuals is shown in the dot charts in Appendix D. Using current green hide quotations to determine hide value, the hide value tended to be

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[1]Engelman, Gerald, op. cit., p. 1426.

a higher percentage of the carcass value in the lower grades. No results were presented on this subject.

The weight of the oleo fats, the caul and ruffle fats, was analyzed for variability by calculating the mean and standard deviation for each carcass grade containing 14 or more individuals.

Table 25. The mean fat weight and standard deviation by carcass grade.

Carcass grade	Number of head	Mean (pounds)	Standard deviation
AA 2	1	16.50	---
AA 3	1	28.75	---
A 1	14	23.71	8.92
A 2	16	21.95	4.89
A 3	40	18.77	4.29
B 1	21	17.75	5.12
B 2	20	16.24	4.79
B 3	1	12.25	---
C 3	4	8.19	---
D 1	21	7.42	1.84
E 1	1	5.75	---

The large standard deviation shown in the above table is an indication that there was considerable variability in the weight of internal fats within each grade. The variability of fat weights of the 40 steers in the low good grade is shown in Fig. 7, Appendix D.

As a result of these preliminary studies, it is the writer's opinion that any variability studies of this type should be done in accordance to grade, sex, live weight and the season of the year before any conclusions are reached.

SUMMARY

The purpose of this study was to determine how accurately the present method of marketing slaughter steers by live weight reflects back to producers the differences in value of different animals to the packer.

The buyer's estimate of grade was compared to both the official grade and the packer grade. The results of this study show that a much closer relationship existed between the buyer's estimate and the packer grade than between the buyer's estimate and the government grade, but that there was still error in the buyer's judgment of grades. The percentage of identical classification between his estimate and the packer grade was 53.0 in comparison with the 21.4 percent between his estimate and the government grade. Also, 78.5 percent of the buyer's estimates were within one-third of the packer grade, and 98 percent were within two-thirds of a grade. When the estimates were compared with the government grade, these percentages were 65 and 84, respectively. The buyer was able to give a fairly accurate estimate as to the whole grade in which an animal would fall, but it was more difficult to place the individual in the finer divisions of the grade.

Since the buyer's estimate of carcass grade was compared with both the government and the packer grade, it was convenient to make a comparison between grading as done by the packer grader and as done by the government graders. Considerable disagreement

between the two grading systems was found. There was agreement on 41.5 percent of the carcasses, the packer grades being higher than the government in 57 percent of the cases and lower in only 1.5 percent.

This study indicates that there is a need for more definite empirical standards for the various carcass grades in order to improve the relationship between the cooperating packer and U. S. government standards which existed in this study.

Yield estimates were subjected to the same tests used on grade estimates. The percentage of correct buyer's estimates was 8.5 percent, while 14.3 percent were too high and 76.2 percent were too low. Yield is such an important determinant of the purchase price of cattle that any inaccuracies on the buyer's part in estimating yield may mean either a loss or gain to the individual producer. However, the buyer should not be too severely criticized for underestimating yield without first evaluating the live weight system of buying under which he must work.

The two price series used in the economic analysis were the historical series and the current series. The historical series was the 1937-1941 average wholesale price of steer and heifer carcasses at Chicago. The current price series was composed of the current wholesale price for each grade and weight group as it was quoted by the cooperating packer on the day of official grading.

Results of this study show that the mean total error per lot per hundredweight, based on the estimated grade and yield and on

the current price, favors the packer by 37 cents. This analysis was based on the estimated live price and not on the actual price paid. With the finer breakdown of grade brought about by the use of the historical price series, the mean total error was zero. Thus, total purchases tended to average zero over a group of lots even though errors did exist for individual lots. Using current prices, price errors in the estimation of yield were greater than those in the estimation of grade. Using historical prices, price errors in the estimation of yield were equal to those in the estimation of grade.

Using the current price, the mean total error per head per hundredweight was a minus 17 cents, the errors in the yield estimates being greater than those in the grade estimates. Using historical prices, the mean total error was a plus 6 cents, the price errors in the estimation of grade being greater than those made in the estimation of yield.

The variance and standard deviation were computed for all mean errors. Theoretically, all buying errors should have been zero. Therefore, the deviation of the errors was measured from zero rather than from the mean error. By comparing the variance of yield to the variance of grade, it was determined which of the estimates was the greater cause in the variance of the total error. When current prices were used, the variance of the mean yield error per hundredweight per lot was nearly twice as important as the mean grade error in causing the variance of the mean total error.

After computing the variance and standard deviation, it was possible to measure the proportionate contribution of the two estimates and the correlation of the estimates to the total price error. Since negative correlations were obtained in this study, it was not possible to accurately state the percentage contribution of each estimate to the total error. However, it was possible to state how much more important one error was than the other. For example, the contribution of yield estimates to the total error was 1.6 times as important as the estimates of grade.

The value of by-products was not considered in the estimated and calculated live price. Although by-products are of value to the packer, it was not within the scope of this thesis to study intensively the effect of their worth on carcass value. Some preliminary studies were conducted on the variability of hide weights and oleo fats, but no conclusions were reached because of the limited number of animals in any grade group.

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APPENDIX

APPENDIX A

Form I.
Marketing Slaughter Cattle by Carcass Grade and Weight
Yard Data: Individual Animal

Lot No._____. Tag No._____. Date_____.

Live Weight_____. Buying Price $_____.

Buyer's Estimate of Yield (hot) in nearest ½%_____.

Buyer's Estimate of Carcass Grade: Hr. Weighed_____.

Grade	1	2	3
Choice			
Good			
Commercial			
Utility			

Breed_____.
Sex_____.
No._____.
Weight Group
_____.
Appraisal Price
_____.

Form II.
Marketing Slaughter Cattle by Carcass Grade and Weight
Killing Floor: Individual Animal

Lot No._____. Tag No._____. Date_____.

Hour Slaughtered_____.

Condemnations:

	Disease	Other (Specify)
Carcass		
Head		
Heart		
Liver		
Lungs		
Other		

Weight of Trim for Bruises, etc._____

Carcass Weight (Hot)_____.

Form III.
Marketing Slaughter Cattle by Carcass Grade and Weight
Hide Cellar: Individual Animal

Lot No._____. Tag No._____. Date_____.

Weight_____. Trim_____lbs.

Class	Sub-class	Grade 1	Grade 2
Steer or Heifer	Native		
	Texas (side branded)		
	Colorado (side branded)		
	Butt-branded		
Cow	Native		
	Branded		

Why Downgraded:

Grubby_____. Tag No._____. Dockage for Dirt_____.

Form IV.
Marketing Slaughter Cattle by Carcass Grade and Weight
Cooler: Individual Carcass

Lot No._____. Tag No._____. Date_____.

Weight (Cold)_____.

Carcass Grade (Official Government Grade):

Grade	1	2	3
Choice			
Good			
Commercial			
Utility			

Form V Lot No._____

Marketing Slaughter Cattle by Carcass Grade and Weight

Instructed Buying Price....._____
(day of purchase)

Weight Group (Carcass)	Grade											
	Choice			Good			Commercial			Utility		
	1	2	3	1	2	2	1	2	3	1	2	3

Hide Quotations. Date:_____
(day of slaughter)

Class	Sub-Class	Heavy		Light		Ext. Light	
		1	2	1	2	1	2
Steer	Native.....						
	Texas.....						
	Colorado.....						
	Butt-branded.....						
Cow	Native.....						
	Branded.....						

Wholesale Price Quotations on Carcasses: Date:_____
(day of grading)

Fresh Beef -- Steer and Heifer

Weight	Choice	Good		Commercial		Utility
		1	2 & 3	1	2 & 3	
300-400 lbs.						
401-500 lbs.						
501-600 lbs.						
601-700 lbs.						

Form VI.

Marketing Slaughter Cattle by Carcass Grade and Weight
Individual Animal: Summary

Date_____

Lot No._____ Tag No.__

Estimated Carcass Grade			
Choice	1	2	3
Good	1	2	3
Commercial	1	2	3
Utility	1	2	3
Cutter	1	2	3
Canner	1	2	3

Actual Carcass Grade			
Choice	1	2	3
Good	1	2	3
Commercial	1	2	3
Utility	1	2	3
Cutter	1	2	3
Canner	1	2	3

Grade Error by 1/3:

Over_____Under_____

Bruises_____

Condemnations_____

_____

Hour Weighed_____

Live Weight_____

Estimated Yield
Cold_____%

Carcass Weight:
Hot_____
Cold_____

Actual Yield
Cold_____

Error of
Estimated Yield_____%

Hide: Weight____lbs.
Class_____
Grade 1__2____
Value per lb.__
Total Value

Hour Slaughtered_____

Offal Credit $_____

Breed:_____ Sex_____

Weight Group_____

Buying Price $_____

Carcass Price:
Chicago $_____
Morrell $_____

Total Carcass Value $_____

Carcass Value per
100 lbs. live weight $_____

Caul Fat_____lbs._____oz.
Ruffle Fat_____lbs._____oz.
Total Fat_____lbs._____oz.

Form VII.
Marketing Slaughter Cattle by Carcass Grade and Weight
Lot Data: Date_____.

Lot No._____. Where Bought_____. Where Weighed_____.

Hour Weighed_____. Total Live Weight_____.

Estimated Yield_____% Total Carcass Weight (cold)_____.

Actual Yield_____% Total Carcass Value_____.

Buying Price (cwt) $_____. Ave. Live Weight_____lbs.

Carcass Value per 100 lbs. Live Weight $_____.

Tag Nos._____

_____.

_____

APPENDIX B

Table 24. Difference between estimated and calculated value per 100 pounds live weight for all lots.

Lot no.	No. head	Total estimated price	Total carcass value	Total live weight	Value cwt. live weight: Estimated	Actual	Error	Total carcass weight	Lot yield (percent): Calculated	Estimated	Error	Total est. carcass value	Av. est. carcass price(cwt)	Value of lot yield error	Value of lot grade error	Lot total error squared	Lot yield error squared	Lot grade error squared	Total appraised value	Appraised price cwt	Error "x"	Lot error "x" squared
Current price																						
1	10	2,371.52	2,396.53	9,790	24.22	24.48	- .26	5,796	59.2	58.0	- 1.2	2,420.42	41.76	- .50	.24	.0676	.2500	.0576	2,576.08	26.31	2.09	4.3681
2	20	3,741.49	4,078.38	15,760	23.74	25.88	- 2.14	9,347	59.3	55.7	- 3.6	3,977.80	42.56	- 1.53	- .61	4.5796	2.3409	.3721	4,076.07	25.86	2.12	4.4944
3	34	9,255.14	9,011.25	30,200	30.65	29.84	.81	17,836	59.0	58.6	- .4	9,317.54	52.24	- .21	1.02	.6561	.0441	1.0404	9,863.70	32.66	2.01	4.0401
4	17	4,241.35	4,346.02	13,725	30.90	31.66	- .76	8,183	59.6	57.9	- 1.7	4,363.19	53.32	- .91	.15	.5776	.8281	.0225	4,537.04	33.06	2.16	4.6656
5	35	8,058.78	8,058.27	25,545	31.55	31.55	.00	15,176	59.4	58.2	- 1.2	8,225.73	54.20	- .65	.65	.0000	.4255	.4225	8,791.67	34.42	2.87	8.2369
6	26	3,947.77	3,920.09	18,745	21.06	20.91	.15	9,689	51.7	49.8	- 1.9	4,090.89	42.22	- .80	.95	.0225	.6400	.9025	3,784.05	20.19	- .87	.7569
Mean errors							- .37							- .77	.40						1.73	
Historical price																						
1	10	909.94	894.69	9,790	9.29	9.14	.15	5,796	59.2	58.0	- 1.2	928.30	16.02	- .19	.34	.0225	.0361	.1156				
2	20	1,384.10	1,535.42	15,760	8.78	9.74	- .96	9,347	59.3	55.7	- 3.6	1,471.83	15.75	- .57	- .39	.9216	.3249	.1521				
3	34	2,774.40	2,656.43	30,200	9.19	8.80	.39	17,836	59.0	58.6	- .4	2,791.89	15.65	- .06	.45	.1521	.0036	.2025				
4	17	1,284.87	1,294.42	13,725	9.36	9.43	- .07	8,183	59.6	57.9	- 1.7	1,320.58	16.14	- .27	.20	.0049	.0729	.0400				
5	33	2,365.24	2,314.79	25,545	9.26	9.06	.20	15,176	59.4	58.2	- 1.2	2,413.72	15.90	- .19	.39	.0400	.0361	.1521				
6	26	1,141.36	1,087.96	18,745	6.09	5.80	.29	9,689	51.7	49.8	- 1.9	1,182.63	12.21	- .23	.52	.0841	.0529	.2704				
Mean errors							.00							- .25	.25							

APPENDIX C

Table 25. Difference between estimated and calculated value per 100 pounds live weight per individuals using the current price.

Lot no.	Tag no.	Live weight	Esti. yield	Esti. grade	Carcass price cwt. est. grade 1/	Estimated live price cwt.	Carcass weight	Calculated yield	Actual carcass grade	Actual carcass price cwt.	Calculated value cwt. carcass	Calculated value cwt. live weight	Error in price cwt.	Price error squared	Price difference of carcass grade	Value of grade error cwt. live weight	Value of grade error squared	Value of yield error: Yield	Value of yield error cwt. live weight	Value of yield error squared	Carcass value per head: 2/	Estimated value per head	Error of estimated value per head	Appraisal price per cwt. 3/	Appraisal value per head	Error "X" per cwt. live wt.	Error "X" per cwt. squared	Carcass value per steer based on estimated grade
3	1	885	58.5	A 3	52.50	30.71	521	58.9	A 3	52.50	27.35	30.90	- .19	.0361	.00	.00	.0000	- .5	- .26	.0676	273.53	271.78	- 1.75	33.00	292.05	2.29	5.2441	273.52
3	2	985	60.0	A 1	53.00	31.80	587	59.6	A 2	52.50	30.82	31.29	.51	.2601	.50	.30	.0900	.5	.26	.0676	308.18	313.23	5.05	33.00	325.05	1.20	1.4400	311.11
3	3	925	59.0	A 2	52.50	30.97	529	57.2	A 3	52.50	27.77	30.02	.95	.9025	.00	.00	.0000	2.0	1.05	1.1025	277.72	286.47	8.75	33.00	305.25	2.03	4.1209	277.72
3	4	830	58.0	B 3	49.00	28.42	476	57.3	B 2	49.00	23.32	28.09	.33	.1089	.00	.00	.0000	.5	.24	.0576	233.24	235.89	2.65	31.00	257.30	2.58	6.6564	233.24
3	5	850	58.5	B 2	49.00	28.66	496	58.4	B 2	49.00	24.30	28.59	.07	.0049	.00	.00	.0000	.0	.00	.0000	243.04	243.61	.57	31.00	263.50	2.34	5.4756	243.04
4	36	1,050	58.0	A 2	52.50	30.45	636	60.6	A 3	52.50	33.39	31.80	- 1.35	1.8225	.00	.00	.0000	-2.5	- 1.31	1.7161	333.90	319.72	- 14.18	33.00	346.50	2.55	6.5025	333.90
5	53	750	58.0	A 2	55.00	31.90	432	57.6	A 3	55.00	23.76	31.68	.22	.0484	.00	.00	.0000	.5	.28	.0784	237.60	239.25	1.65	34.50	258.75	2.60	6.7600	237.60
6	86	665	50.0	D 2	40.00	20.00	340	51.1	D 1	40.00	13.60	20.45	- .45	.2025	.00	.00	.0000	-1.0	- .40	.1600	136.00	133.00	- 3.00	19.00	126.35	- 1.00	1.0000	136.00

1/ The analysis was used for both price series by changing the price in this column.

2/ Based on actual carcass grade.

3/ Not used in analysis with historical prices.

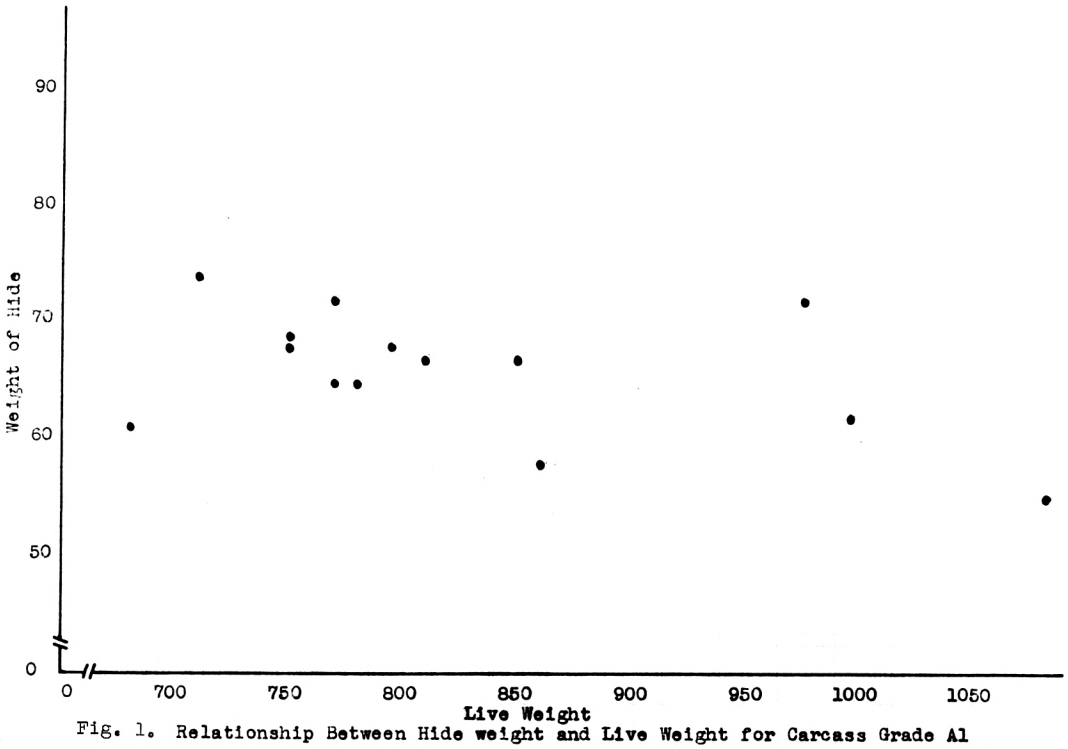

Fig. 1. Relationship Between Hide weight and Live Weight for Carcass Grade A1

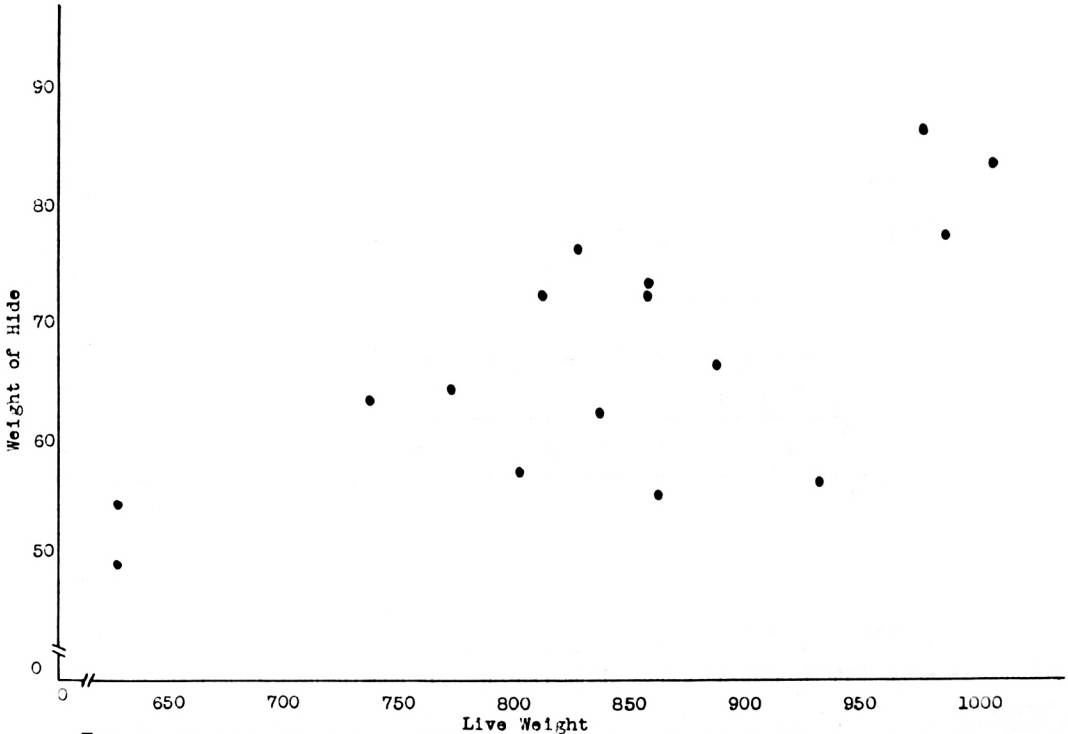

Fig. 2. Relationship Between Hide Weight and Live Weight for Carcass Grade A2

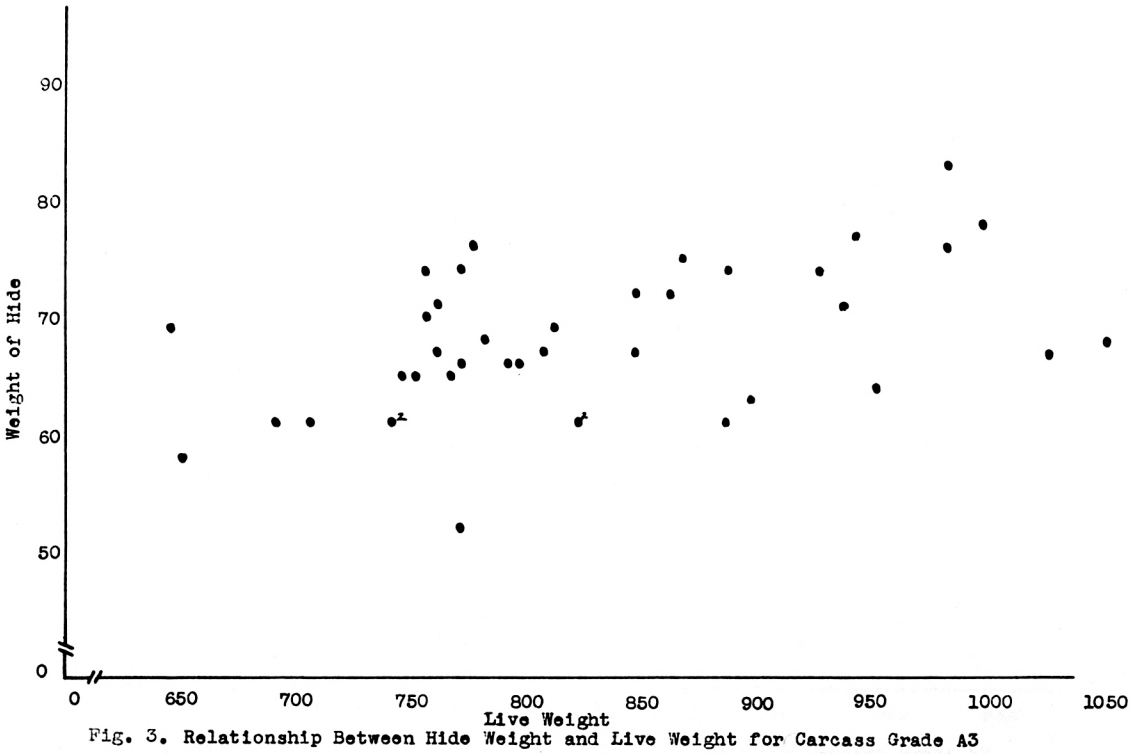

Fig. 3. Relationship Between Hide Weight and Live Weight for Carcass Grade A3

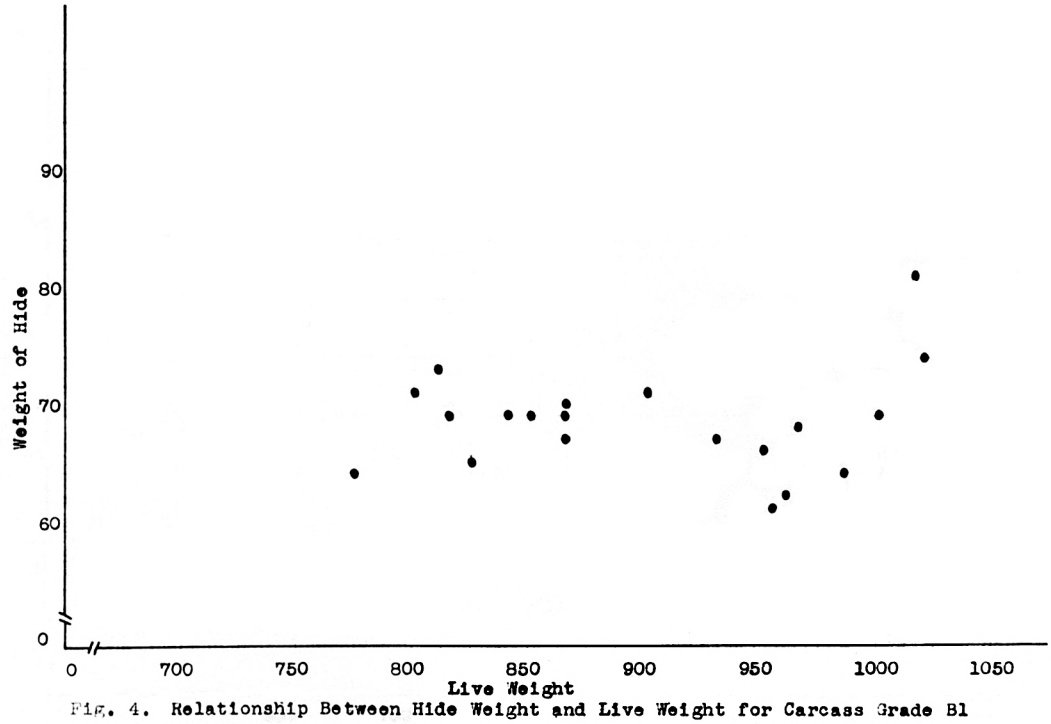

Fig. 4. Relationship Between Hide Weight and Live Weight for Carcass Grade B1

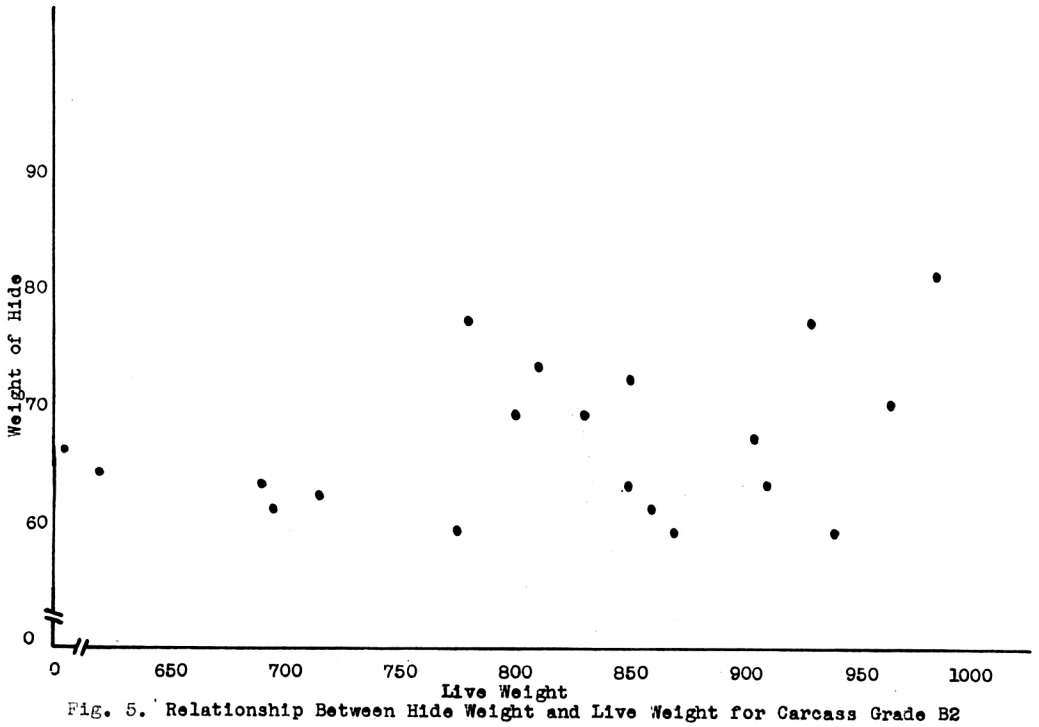

Fig. 5. Relationship Between Hide Weight and Live Weight for Carcass Grade B2

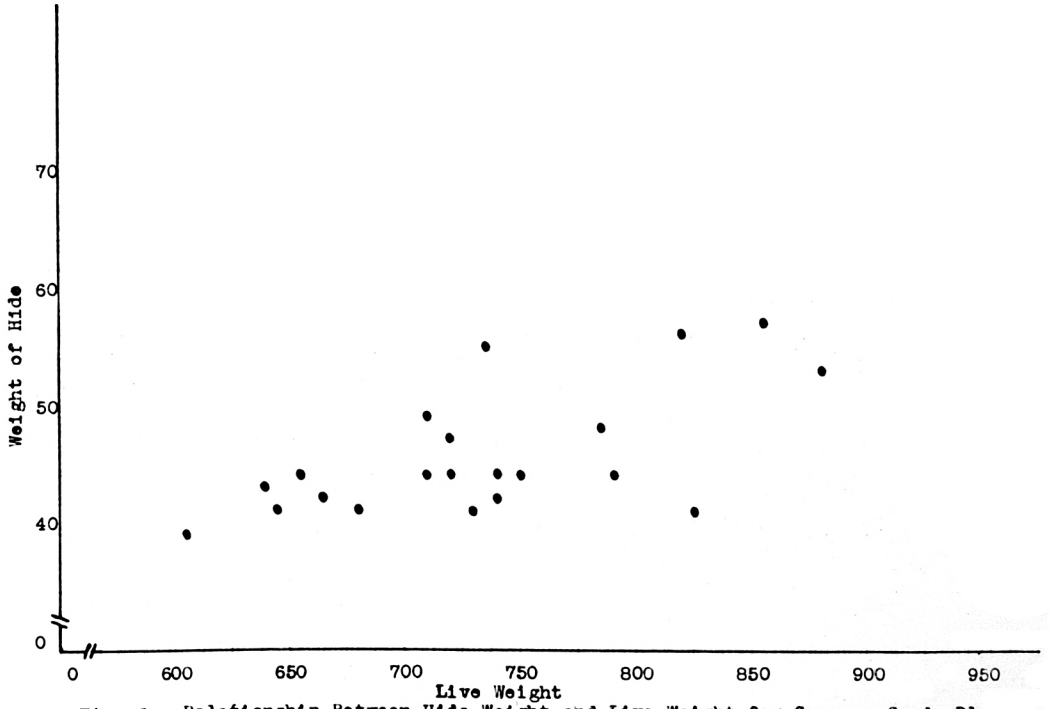

Fig. 6. Relationship Between Hide Weight and Live Weight for Carcass Grade D1

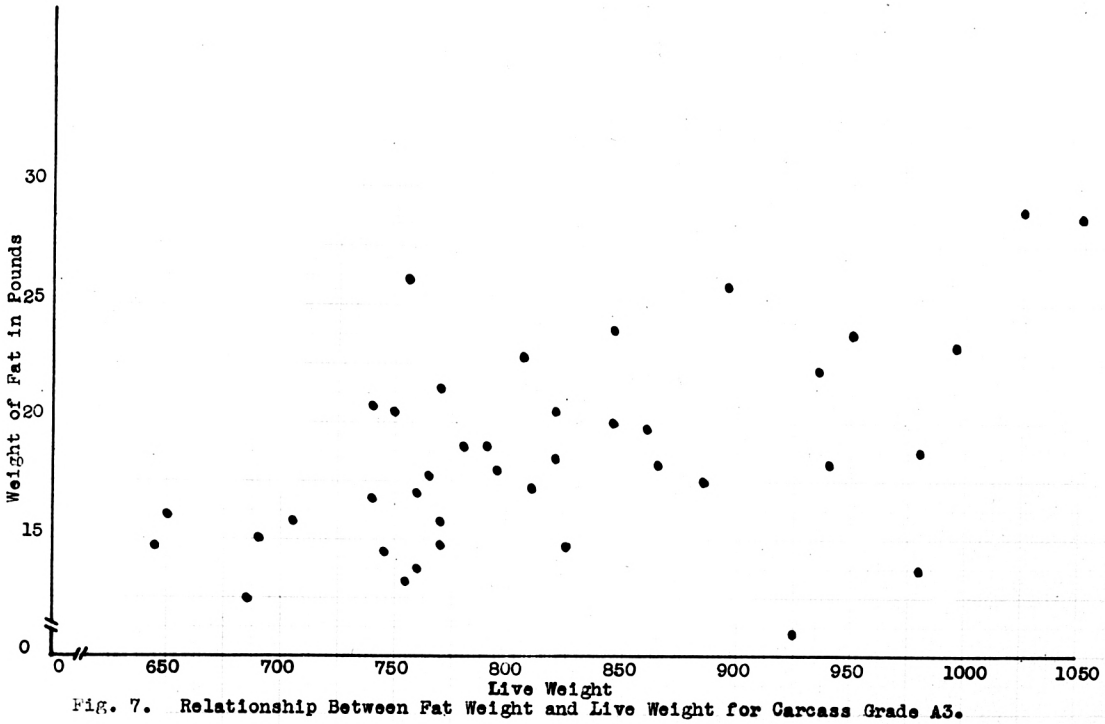

Fig. 7. Relationship Between Fat Weight and Live Weight for Carcass Grade A3.